# FUNCTIONAL ASSEMBLAGES OF BIRDS IN HETEROGENEOUS LANDSCAPES ALONG AN URBAN-RURAL GRADIENT IN TIRUCHIRAPPALLI, INDIA

MANJULA MENON<sup>1,2</sup>, PRASHANTHI DEVI<sup>1,3</sup> AND R. MOHANRAJ<sup>1,4</sup>

<sup>1</sup>Department of Environmental Management, School of Environmental Sciences, Bharathidasan University, Trichy 620 024, Tamil Nadu, India. <sup>2</sup>Email: manj.m@gmail.com <sup>2</sup>Email: prashanthidevi@gmail.com <sup>4</sup>Email: mohan.bud@gmail.com

As a result of urbanisation, landscapes and land use patterns are changing the world over. This extreme form of land use alteration has affected species composition and abundance, moulding a few species to dominate the urban environment and a few others to extinction. Urbanisation occurs at different scales and the community composition of species gets affected accordingly. In this paper, we look into species richness and abundance of birdls, and their variation along an urban-rural gradient at Truchirappalli, India. In Truchirappalli, Bird species diversity increases from more to less urbanised centres. Though diversity is less in urban areas, the abundance of species occupying these areas is higher. During this study, the maximum recorded birdls were cominovers. The most affected species is the House Sparrow, with a few populations residing in the urban environment. Along the urban-rural gradient at Truch and wetlands are the most preferred landscapes of birdls, and conservation measures need to be oriented in this direction to protect the most vulnerable species. Species diversity in urban areas is significantly contributed to by edge species that occupy the fringes of urban areas. Though urban landscapes are less species rich, they too play a significant role in biodiversity conservation as they are species abundant zones. City planners and urban foresters need to pay more attention towards preserving habitats not only in urban areas but along the urban fringes, as they provide suitable corridors for various activities of birds and their movement.

Key words: urbanisation, abundance, richness, homogenization, ecosystem, biodiversity, communities

## INTRODUCTION

Urbanisation often modifies landscapes and land use patterns, leading to changes in the vegetation and altering species composition. Urban ecosystems are characterised by low stability, complex and varied dynamics, abundance of exotic species, and different species composition (Machlis et al. 1997). Human domination of ecosystems leads to excessive consumption of resources (Turner et al. 1991), alteration of habitats and species composition (McKinney 2002), disruption of hydrological processes (Arnold and Gibbons 1996), and modification of energy flow and nutrient cycles (Grimm et al. 2000; Vitousek et al. 1997). Humans have modified the carbon cycle (Prentice 2001) to an extent that it has lead to the expulsion of large quantities of toxic gases into the atmosphere (Pacyna and Pacyna 2001). Urbanisation drives biotic homogenization (McKinney 2006; McKinney and Lockwood 1999) and it affects the communities found along an urban-rural gradient. When habitat heterogeneity decreases, landscapes often undergo homogenization, and similar species occupy these habitats causing extinction of the endemics (McKinney 2006; Olden 2006).

Studying faunal composition along an urban-rural gradient helps in understanding various ecosystem processes at landscape level. This is a unique area of research. In the concept of an urban-rural gradient, suburban habitats play a unique role in biodiversity conservation. These habitats can be ideal zones for birds and would contain half of the species found in forested areas if they are less exposed to developmental activities (Blair 2004) and high densities of birds in urban areas (Palomino and Carrascal 2006), Species richness peaks at the intermediate level of urbanisation (Tratalos et al. 2007). Some species thrive well in areas of high development, but certain other species are sensitive to various stress factors in the environment and are forced to extinction (Jackson 2006). Some prime factors that affect bird community composition and abundance along an urban-rural gradient include proximity to roads, developmental activities (Brotons and Herrando 2001; Fraterrigo and Wiens 2005; Glennon and Porter 2005), and density of buildings (Fraterrigo and Wiens 2005: Friesen et al. 1995). Landscape modification and diversity of habitats for various life forms, makes urban areas a priority area for conservation (Miller and Hobbs 2002).

### MATERIAL AND METHODS

# Study Area

Tiruchirappalli, one of the southernmost cities of India, is a historical city. With an area of 4,404 sq. km, it is the fourth largest city in Tamil Nadu, located at the geographic



Fig. 1: Sampling points along an urban-rural gradient

centre of the state (10°-11°30' N: 77°45'-78°50' E). The population of the city in 2009 was 829,537. The city lies along the rivers Cauvery and Coleeron, witnessing a high rate of urban agglomeration. It has a number of disconnected hills. among which Pachamalai Hill is the most important, located in the Sengattupatti reserve. The district is agriculturally rich due to its fertile land and perennial rivers. The vegetation is mainly Tropical Dry Deciduous forest and Tropical Thorn forest. The River Cauvery with its numerous distributaries enables extensive paddy cultivation throughout the year. Tiruchirappalli is also among the important industrial cities in Tamil Nadu, with BHEL and HAPP as the major manufacturing units. It is also a major pilgrimage destination with centuries old temples being the major attraction for tourists and a unique habitat for a large number of resident birds. Urbanisation and industrialisation have triggered infrastructure expansion, mushrooming of residential complexes and other commercial developments, leading to large-scale landscape alterations, including changes in seasonal wetlands. These altered landscapes are likely to mould bird species composition and their habitats.

# Methodology

Sampling was carried out from October 2010 to September 2011, through 151 point counts to study the effect of landscape changes on species richness and abundance of birds. Sampling points were selected within the city and along the urban-rural gradient. 80 sampling points were selected in the urban, 17 in the suburban and 54 in the rural matrix. At each point, birds were identified and enumerated within 25 m radius for 10 minutes, by the point count method (Bibby et al. 2000). The sampling points were visited from 06:00 to 09:00 hrs every month to record bird abundance and richness. All the sampling points within the urban boundary were at distances of 500 m, while along the urban to rural gradient, they were located at a distance of 800 m to 1 km. The points were marked using GPS on eight different roads diverging from the city covering a total area of 900 sq. km (Fig. 1). Survey was avoided on rainy and windy days. The bird species recorded were divided into six foraging guilds: carnivore, granivore, frugivore, insectivore, omnivore, and nectarivore. To evaluate how habitat fragmentation in the urban areas and along the urban-rural gradient affected species composition, bird



Fig. 2: Species abundance along an urban-rural gradient



#### **Data Analysis**

Shannon Wiener species diversity index (Maguran 2004) was calculated within various urban landscapes along the gradient. Niche breadth was calculated to find out the range of resources utilised along the axis (Morin 1999). Species richness, species abundance (Fig. 2), and species evenness were also calculated for different landscapes. The similarity of bird assemblages occupying different landscapes was quantified by Percent of Similarity given by Bray and Curtis (1957). ANOVA recorded the significant difference in diversity indexes of species occupying different landscapes.

#### RESULTS

A total of 140 species, belonging to 59 families, were recorded during the study with a pooled diversity index of H = 0.9 (Table 1). The diversity index of rural locations was higher followed by suburban and urban (Fig. 3). The results showed significant difference in the diversity indexse of species occupying the urban-rural gradient (F = 36.76, P = 0.000). Niche breadth did not vary significantly along the gradient (F = 1.43, P = 0.239). Classification of birds based on their trophic status showed a higher density of omnivores (43%) occupying the urban matrix, followed by carnivores (25%), insectivores (17%), nectarivores (8%),

Table 1: Comparison of different indices between urban, suburban, and rural landscapes

Landscapes	Diversity Index	Species Richness	Niche breadth	Species Evenness
Urban	0.82	67	0.22	0.66
Suburban	1.02	85	0.10	0.70
Rural	1.08	137	0.20	0.75

J. Bombay Nat. Hist. Soc., 109 (1 & 2), Jan-Aug 2012



Fig. 3: Diversity index along an urban-rural gradient

granivores (2%), and frugivores (1%). The omnivorous species that were abundant in urban areas were *Milvus migrans*, *Turdoides affinis*, and *Corvus splendens*.

Species richness varied from urban to rural locations, being the highest in the rural matrix (137 species), followed by suburban (85 species), and urban (67 species). The percentage of taxonomic similarity between species occupying the urban and rural landscapes is the lowest at 59%; 72% between urban and suburban; and 63% between suburban and rural.

Along the urban-rural gradient, agricultural landscapes and wetlands are the most preferred habitat for birds, and Bucalypus plantations are the least preferred. In urban areas, higher abundance of birds was found in locations that had a matrix of residential-commercial land use, rather than purely residential or purely commercial. Agricultural landscapes recorded higher density of insectivores, and wetlands were dominated by Ardeidae species, such as Pond herons (Ardeola gravii) and egrets (*Egretta intermedia*, *Egretta garzetta*, and *Bubulcus coromandus*). Diversity index was highest during the southwest monsoon in all landscapes, as seasonal wetlands



Fig. 4: Scale of diversity among seasons in different landscapes

harbour large numbers of species during the monsoon (Fig. 4). Native tree species Azadirachta indica, Tamarindus indica, Ficus benghalensis, and Ficus religiosa were found to harbour a large number of bird species in the urban areas, and shrubs Prosopis juliflora and the reed Typha provide good habitat

# Table 2: List of bird species recorded based on their foraging guild

Accipiler badus     Accipitridae     Carnivore     Egretta garzetta     Ardeintae     Carnivore       Accipitridae     Carnivore     Elenus caeruleus     Accipitridae     Carnivore       Accopatris     Sundata     Carnivore     Elenus caeruleus     Accipitridae     Carnivore       Acrocephatis agricola     Acrocephatis agricola     Acrocephatis agricola     Cuculidae     Granivore       Actita hypoleucos     Sociopacidae     Carnivore     Francolinus pictus     Phasianidae     Ornivore       Alluda guigula     Alauda guigula     Alauda duidae     Ornivore     Galerida cristata     Alluidae     Insectivore       Anas pocifornyncha     Analidae     Ornivore     Galinua chorpus     Ralidiae     Ornivore       Anas pocifornyncha     Analidae     Ornivore     Galinua chorpus     Sternikae     Ornivore       Anas pocifornyncha     Analidae     Carnivore     Halison innoica     Sternikae     Ornivore       Anas pocifornyncha     Analidae     Carnivore     Halison innoica     Sternikae     Ornivore       Anas pocininnyncha     Analidae     Carnivore <th>Species</th> <th>Family</th> <th>Foraging Guild</th> <th>Species</th> <th>Family</th> <th>Foraging Guild</th>	Species	Family	Foraging Guild	Species	Family	Foraging Guild
Accipitridae     Camivore     Elinia caerulisus     Accipitridae     Carnivore       Acrocaphalus agricola     Acrocaphalus agricola     Acrocaphalus agricola     Canvore     Eudyamys scolapacus     Cuculidae     Granvore       Acrocaphalus agricola     Acrocaphalus agricola     Carnivore     Eudyamys scolapacus     Cuculidae     Granvore       Actili hypoleucos     Scolopacidae     Carnivore     Francolinus policerianus     Phasianidae     Ornivore       Alauda gugula     Alaudidae     Ornivore     Galerida cristala     Alaudidae     Ornivore       Anazornis phoenicura     Ralidae     Ornivore     Galerida cristala     Alaudidae     Ornivore       Anazornis phoenicura     Ralidae     Granvore     Galerachicrare     Ralidae     Ornivore       Anas guerguedula     Analdae     Granvore     Galerachicrare     Ralidae     Ornivore       Anas guerguedula     Analdae     Granvore     Halayon simpresis     Halcyon dave     Carnivore       Anas guerguedula     Analdae     Granvore     Halayon simpresis     Halcyon dave     Carnivore       Anas stepsera	Accipiter badius	Accipitridae	Carnivore	Egretta garzetta	Ardeidae	Carnivore
Acridotheres trisis     Stumidae     Ornivore     Erempterix griesus     Altudicae     Carrivore       Acrocophalus dumetorum     Acrocophalus dumetorum     Acrocophalus dumetorum     Cualidae     Granvore       Acrosophalus dumetorum     Acrocophalus dumetorum     Acrocophalus dumetorum     Phasiandae     Granvore       Adauda guigula     Aegithinidae     Insectivore     Francolinus pondicerianus     Phasiandae     Ornivore       Alauda guigula     Alaudae     Canivore     Galintarc cintera     Alaudae     Insectivore       Anas positionynch     Analdae     Ornivore     Galinula cintarus     Sumidae     Ornivore       Anas positionynch     Analdae     Ornivore     Galinula cintarus     Sumidae     Ornivore       Anas goechorynch     Analdae     Carnivore     Halison initalea     Ornivore       A	Accipiter nisus	Accipitridae	Carnivore	Elanus caeruleus	Accipitridae	Carnivore
Acrocephalis agricola     Acrocephalista     Insectivore     Eudynamys scolapacus     Cuculidae     Granvore       Acrocephalista     Insectivore     Francolirus pictus     Phasianidae     Granvore       Aditis hipoleucos     Scolopacidae     Carnivore     Francolirus pondicerianus     Phasianidae     Ormivore       Aggithita liphia     Alegithita     Alegit	Acridotheres tristis	Sturnidae	Omnivore	Eremopterix griseus	Alaudidae	Carnivore
Acrocephalus dumeitorum     Acrocephalus     Endide malabaria     Estrilidae     Granvore       Adtils hypolexos     Scolpaaddae     Carnivore     Francolnus potda     Phasianidae     Ormivore       Aguitha talphia     Aegtihnidae     Insectivore     Francolnus potda     Phasianidae     Ormivore       Acada guiguta     Alaudidae     Ormivore     Galificat cistata     Alaudidae     Insectivore       Anas potein/mych     Anatidae     Carnivore     Galificat cistata     Alaudidae     Ornivore       Anas potein/mych     Anatidae     Carnivore     Galicohali chinopus     Stamidae     Carnivore       Anas potein/mych     Anatidae     Carnivore     Halagyon smyrnensis     Halogyon smyrnensis     Halogyon smyrnensis     Halogyon smyrnensis     Halogyon smyrnensis     Halogyone     Anthus ichande     Carnivore       Anthus ichand     Matalificae     Insectivore     Himantopus     Acacipitidae     Carnivore       Anthus ichand     Matalificae     Carnivore     Himantopus     Carnivore     Acapyon palannes     Anthus ichande     Insectivore       Anthus ichand     Ardeida	Acrocephalus agricola	Acrocephalidae	Insectivore	Eudynamys scolopaceus	Cuculidae	Omnivore
Actilis hypoleucos     Scolopacidae     Carnivore     Francolinus pictus     Phasianidae     Onnivore       Aluda gulgula     Alaudidae     Ormivore     Francolinus pondicorianus     Palasianidae     Ormivore       Aleda attinis     Alaudidae     Ormivore     Galerida cristata     Alaudidae     Insectivore       Ansa piarytinnoto     Anatidae     Ormivore     Galerida cristata     Baladiae     Ormivore       Ansa pacellorhyncha     Anatidae     Ormivore     Galerida cristata     Starnidae     Ormivore       Ansa poerpucula     Anatidae     Granivore     Galerida conta     Starnidae     Ormivore       Ansa guerguedula     Anatidae     Granivore     Halzyon simperniss     Alagonidae     Camivore       Anastorus sociatas     Cicolidaa     Carnivore     Hierococyver varius     Cuculidae     Carnivore       Antus ruhula     Motacillidae     Insectivore     Hierodocyver varius     Caculidae     Carnivore       Antus ruhula     Motacillidae     Insectivore     Laniko ruhusia     Accepticata     Accepticata       Antus ruhula     Motacilidae	Acrocephalus dumetorum	Acrocephalidae	Insectivore	Euodice malabarica	Estrildidae	Granivore
Aegithinida     Aegithinidae     Insectivore     Francolinus pondicarianus     Phasianalo     Chrunvere       Alcuda guigui     Alcudidae     Ornnivore     Galidria cristata     Alcudidae     Insectivore       Anauromis phoenicura     Ralidae     Ornnivore     Galilicrex cinerae     Ralidae     Ornnivore       Anas poelontyrah     Anatidae     Granivere     Galicrex cinerae     Ralidae     Ornnivore       Anas pagentyrah     Anatidae     Carnivere     Gracupica contra     Sturnidae     Carnivere       Anas stepera     Anatidae     Carnivere     Hallastri indus     Accipitidae     Carnivere       Anas stepera     Anatidae     Carnivere     Hirancoacyx varius     Quegitidae     Carnivere       Antus riunus scatans     Ciconidaa     Carnivere     Hirando rusica     Hirundo rusica     Hirundo rusica     Hirundo rusica     Ardeidae     Carnivere       Apus ripalensis     Apodidae     Carnivere     Lanks cristatus     Lanidae     Gravivre       Artus diusa     Ardeidae     Carnivere     Lanks cristatus     Lanidae     Gravivre	Actitis hypoleucos	Scolopacidae	Carnivore	Francolinus pictus	Phasianidae	Omnivore
Alauda gulgula     Alaudidae     Omnivore     Fullica atra     Ballidae     Omnivore       Acedo attivis     Alcadi datti     Galerida cristata     Alaudidae     Omnivore       Armomanes phoenicura     Alaudidae     Insectivore     Galerida cristata     Alaudidae     Omnivore       Anas plarityrinchoa     Anatidae     Omnivore     Galerac cherea     Rallidae     Omnivore       Anas poecilorhyricha     Anatidae     Granivore     Halzyon symmensis     Halzyon symmensis     Cacmivore       Anas guergudula     Anatidae     Granivore     Halzyon symmensis     Acceptinidae     Camivore       Anastorus socians     Cicolidae     Camivore     Hinantopus himantopus     Recurvisoridae     Camivore       Anthus ruhula     Motacillidae     Insectivore     Hinantopus himantopus     Recurvisoridae     Camivore       Apos najatensis     Apodidae     Camivore     Lapicopasianus chirurgus     Jacaridae     Camivore       Ardea grayi     Ardeidae     Camivore     Lapicoma zaylonica     Nectarinidae     Nectarinidae       Aratus dulau     Insectivore     Lapicomaz	Aegithina tiphia	Aegithinidae	Insectivore	Francolinus pondicerianus	Phasianidae	Omnivore
Abedo atthis     Abedinidae     Camivore     Galierida cristata     Alaudidae     Insectivore       Anauronia phoenicura     Alaudidae     Insectivore     Galieras cherea     Raliidae     Ornnivore       Anas poelinyminch     Anatidae     Ornnivore     Gelochelidon nitolica     Sternidae     Carnivore       Anas poelinyminch     Anatidae     Carnivore     Haldsyninindus     Sternidae     Carnivore       Anas streper     Anatidae     Carnivore     Halastrindus     Cuculidae     Carnivore       Anas streper     Anatidae     Carnivore     Hiranctous hirandous     Cuculidae     Carnivore       Anthus richand     Motacillidae     Insectivore     Hiranctous and anaus     Carnivore       Anthus richand     Andecillidae     Insectivore     Hiranchous     Ardeidae     Carnivore       Ande antivaria     Andeidae     Carnivore     Lanks cristatus     Lanidae     Insectivore       Andes anyurea     Ardeidae     Carnivore     Lonchura articapila     Estindidae     Granvore       Anaus fuscus     Artanidae     Insectivore     Marce articapylacyl	Alauda gulgula	Alaudidae	Omnivore	Fulica atra	Rallidae	Omnivore
Amauromis phoenicura     Ralidae     Onnivore     Gallicrac cinerae     Ralidae     Onnivore       Anas platyrhynchos     Anatidae     Ornnivore     Gallicrac cinera     Stanidae     Ornnivore       Anas platyrhynchos     Anatidae     Ganivore     Gracupica contra     Stanidae     Ornnivore       Anas querquedula     Anatidae     Ganivore     Halcson symmensis     Halcyonidae     Canivore       Anas storus socitans     Ciccilidae     Ganivore     Halastur indus     Anatidae     Canivore       Anthus rubutas     Motacilidae     Insectivore     Himantopus Insantopus     Reacivorestrication     Finundinidae     Insectivore       Anthus rubutas     Motacilidae     Insectivore     Lanikos cristatus     Lanikos cristatus     Lanikos     Canivore       Ardea cinerea     Ardeidae     Carnivore     Lanikos cristatus     Lanikos     Realidae     Ganivore       Ardea cinerea     Ardeidae     Carnivore     Lanikos cristatus     Lanikos     Realidae     Ganivore       Ardea cinerea     Ardeidae     Carnivore     Lanichas arinaguta     Redidae     G	Alcedo atthis	Alcedinidae	Carnivore	Galerida cristata	Alaudidae	Insectivore
Ammonanes phoenicum     Alaudidae     Insectivore     Gallinula chioropus     Relia comivore     Comivore       Anas poecilorhyncha     Anatidae     Granivore     Galcopica contra     Stumidae     Carnivore       Anas poecilorhyncha     Anatidae     Granivore     Halcyon snymensis     Halcyon damota     Carnivore       Anas strepera     Anatidae     Granivore     Halcyon snymensis     Halcyon damota     Carnivore       Anas strepera     Anatidae     Granivore     Halcyon snymensis     Hacyonidae     Carnivore       Anthus richandi     Motacillidae     Insectivore     Hirundo nusica     Hirundo nusica     Hirundo nusica     Hirundo nusica     Insectivore       Ande singues     Ardeidae     Carnivore     Lapks cristatus     Lanika     Insectivore       Ardea purpure     Ardeidae     Carnivore     Lanchura strizagila     Estrilidiae     Granivore       Ardea purpure     Ardeidae     Carnivore     Lonchura strizagila     Estrilidiae     Granivore       Ardea purpure     Ardeidae     Carnivore     Lonchura strizagila     Estrilidiae     Granivore	Amaurornis phoenicurus	Rallidae	Omnivore	Gallicrex cinerea	Rallidae	Omnivore
Anas padinympraha   Analidae   Ornivore   Galochelidon nilotica   Sturnidae   Carnivore     Anas querquedula   Anatidae   Granivore   Halcyon striymensis   Halcyonidae   Carnivore     Anas deverpuedula   Anatidae   Granivore   Halcyon striymensis   Halcyonidae   Carnivore     Anas true socitans   Cicculidae   Carnivore   Hirantopus himantopus   Recurvitoritidae   Carnivore     Anthus sichardi   Motacilidae   Insectivore   Hirundinidae   Insectivore     Apus njalensis   Apodidae   Insectivore   Hirundinidae   Carnivore     Ardes cinerea   Ardeidae   Carnivore   Laniks cristatus   Lanika   Insectivore     Ardes apurpure   Ardeidae   Carnivore   Lonchura punctulata   Estrilidiae   Rectarivore     Ardeo grayii   Ardeidae   Carnivore   Lonchura punctulata   Estrilidiae   Granivore     Ardeo as striata   Ardeidae   Carnivore   Lonchura punctulata   Estrilidiae   Granivore     Ardeo as striata   Ardeidae   Carnivore   Morgaliama hearnacephala   Morgaliamidae   Mororivore     Ardeidae	Ammomanes phoenicura	Alaudidae	Insectivore	Gallinula chloropus	Rallidae	Omnivore
Anas poecilorhyncha     Anatidae     Gracupia contra     Studiae     Omnivore       Anas guergueduia     Anatidae     Granivore     Halison symmensis     Haloyonidae     Camivore       Anas strepera     Anatidae     Granivore     Haliastur indus     Accipitridae     Omnivore       Antus sichans     Ciccniidae     Granivore     Hiardorus immaniopus     Recurviostridae     Camivore       Antus sichans     Odocilidae     Insectivore     Hiundo rusica     Hiurididae     Insectivore       Antus indus     Motacilidae     Insectivore     Hydrophasianus chirurguus     Jacanidae     Omnivore       Antas diarea     Ardeidae     Camivore     Lanks sristatus     Lanidae     Insectivore       Ardea purpurea     Ardeidae     Camivore     Lonchura striatia     Estrididae     Granivore       Ardea grayii     Ardeidae     Camivore     Magalam haemacephal     Megalamidae     Omnivore       Bubulcus coromandus     Ardeidae     Camivore     Megalam haemacephal     Megalamidae     Insectivore       Caprimulgus astatus     Caralivore     Merops seschenauti	Anas platyrhynchos	Anatidae	Omnivore	Gelochelidon nilotica	Sternidae	Carnivore
Anas querquedulaAnatidaeCarnivoreHalcyon strymensisHalcyon (strymensis)Halcyon (strymensis)Halcyon (strymensis)CarnivoreAnas stropus oscitansCiccnildaeCarnivoreHierococcyx variusCuculidaeCarnivoreAnthus strictardiMotacilidaeInsectivoreHierococcyx variusCuculidaeCarnivoreAnthus strictardiMotacilidaeInsectivoreHirundiridaeCarnivoreApus nipalensisApodidaeInsectivoreHydrophasianus chiurgusJacanidaeOnnivoreArdea daneraaArdeidaeCarnivoreLonchura strica striatusLanidaeInsectivoreArdeola grayiiArdeidaeCarnivoreLonchura purculataEstrilidaeGranivoreArdeola grayiiArdeidaeCarnivoreLonchura purculataEstrilidaeGranivoreBubducs coromandusArdeidaeCarnivoreLonchura purculataEstrilidaeGranivoreBubducs coromandusArdeidaeCarnivoreMerops leschenaultiMeropidaeInsectivoreCalandrella brachydachylaAlaudidaeInsectivoreMerops leschenaultiMeropidaeInsectivoreCalandrella brachydachylaCaurilidaeGarnivoreMirops singansAcjoidaeInsectivoreCalandrella brachydachylaCaurilidaeGarnivoreMerops leschenaultiMeropidaeInsectivoreCalandrella brachydachylaCaurilidaeGarnivoreMirops singansisAcidiaeCarnivoreCalandrella brachydachylaCaurilidaeInsecti	Anas poecilorhyncha	Anatidae	Granivore	Gracupica contra	Sturnidae	Omnivore
Anas terperaAnalidaeGranivoreHaliastur indusAcolitidaeOmnivoreAnastornus oscitansCiconildaeCarnivoreHierococyx variusCuculidaeCarnivoreAnhus richardiMotacilidaeInsectivoreHirundo rusicaHirundiridaeInsectivoreApus inplansisApodidaeInsectivoreHirundo rusicaHirundiridaeInsectivoreApus inplansisApodidaeInsectivoreHydrofhasianus chirurgusJacanidaeCarnivoreArdea chareaArdeidaeCarnivoreLobbychus cinnamomeusArdeidaeCarnivoreArdea purpreaArdeidaeCarnivoreLonchura atricapilaEstrilidaeGranivoreArdeida grayiiArdeidaeCarnivoreLonchura atricapilaEstrilidaeGranivoreArdeno grayiiArdeidaeCarnivoreLonchura striataEstrilidaeGranivoreBubulcus comandusArdeidaeCarnivoreMegalaima haemaceptaiaMegalaimidaeInsectivoreBubulcus comandusArdeidaeInsectivoreMerops leschenautiMeropidaeInsectivoreCarlindus astalicusCarniudigaeInsectivoreMerops philippirusMeropidaeInsectivoreCarlindus astalicusCarniudigaeCarnivoreMirotagiaeInsectivoreCarlindus astalicusCarniudigaeCarnivoreMirotagiaeInsectivoreCarlindus astalicusCarniudigaeCarnivoreMerops philippirusMeropidaeInsectivoreCarlandria banachacychytiAlaudidae	Anas querquedula	Anatidae	Carnivore	Halcyon smymensis	Halcyonidae	Carnivore
Anastonus ascitans     Ciocnitaa     Carnivore     Hierococcyv strius     Cuolidae     Carnivore       Anthus rinduus     Motacillidae     Insectivore     Hirundo rustica     Hirundo rustica     Rocurviostridae     Carnivore       Anthus rinduus     Motacillidae     Insectivore     Hirundo rustica     Hirundo rustica     Hirundo rustica     Insectivore       Apus nipalensis     Apodidae     Insectivore     Arder de carnivore     Arderidae     Carnivore       Ardea cinerea     Ardeidae     Carnivore     Lonchura strizagita     Estrilidiae     Granivore       Ardea purpura     Ardeidae     Carnivore     Lonchura strizagita     Estrilidiae     Granivore       Arden purpura     Ardeidae     Carnivore     Lonchura strizagita     Estrilidiae     Granivore       Ardenus fuscus     Ardeidae     Carnivore     Lonchura strizagita     Estrilidiae     Granivore       Bubulcus coromandus     Ardeidae     Carnivore     Meropi seschanuti     Meropidae     Insectivore       Arben brama     Strigidae     Insectivore     Meropis seschanuti     Meropidae     Insectivore	Anas strepera	Anatidae	Granivore	Haliastur indus	Accipitridae	Omnivore
Anthus inchardi     Motacililidae     Insectivore     Himantopus himantopus     Recurvostridae     Camivore       Anthus ruluus     Motacililidae     Insectivore     Hirundo nusica     Hirundinidae     Insectivore       Anthus ruluus     Motacililidae     Insectivore     Hirundo nusica     Motacilidae     Comivore       Anthas ruluus     Andeidae     Camivore     Lanika cristatus     Lanika cristatus     Lanika cristatus     Insectivore       Ardea la purpurea     Ardeidae     Camivore     Lanchura striata     Estrilidae     Granivore       Artamus fuscus     Antanidae     Insectivore     Lonchura striata     Estrilidae     Granivore       Bubicitos coromandus     Ardeidae     Camivore     Merops ieschenaulti     Meropidae     Insectivore       Calandrella brachydachyla     Aladidae     Insectivore     Merops orianiais     Meropidae     Insectivore       Calandrella brachydachyla     Aladidae     Insectivore     Merops orianiais     Meropidae     Insectivore       Calandrella brachydachyla     Aladidae     Insectivore     Mirota attritamerodiaa     Ardeidae     Canivore <td>Anastomus oscitans</td> <td>Ciconiidae</td> <td>Carnivore</td> <td>Hierococcyx varius</td> <td>Cuculidae</td> <td>Carnivore</td>	Anastomus oscitans	Ciconiidae	Carnivore	Hierococcyx varius	Cuculidae	Carnivore
Arithus rululus     Motacilitale     Insectivore     Hirundo nutica     Hirundo nut	Anthus richardi	Motacillidae	Insectivore	Himantopus himantopus	Recurvirostridae	Carnivore
Apus najalansis     Apodidae     Insectivore     Hydrophasianus chiurgus     Jacanidae     Omnivore       Egretta alba     Ardeidae     Carnivore     Lixbrychus cinnamoreus     Ardeidae     Carnivore       Ardea cinerea     Ardeidae     Carnivore     Lanika cristatus     Lanika cristatus     Lanika     Carnivore       Ardeo grayii     Ardeidae     Carnivore     Lanika cristatus     Netarivore     Ardeo grayii     Ardeidae     Carnivore       Ardena transita     Stradidae     Insectivore     Lonchura punctulata     Estrilidiae     Granivore       Artane brana     Strijdae     Carnivore     Megalarus palustris     Locustellidae     Granivore       Bubricus commandus     Ardeidae     Carnivore     Meropis lescharauti     Meropidae     Insectivore       Calandrella brachydacyla     Alaudidae     Insectivore     Merops lescharauti     Meropidae     Insectivore       Carnivous bengalensis     Cuculidae     Carnivore     Mirota atriba     Meropidae     Insectivore       Carnivous bengalensis     Cuculidae     Carnivore     Mirata atriba     Alaudidae	Anthus rufulus	Motacillidae	Insectivore	Hirundo rustica	Hirundinidae	Insectivore
Egretta alba     Ardeidae     Carnivore     Kobrychus chnamomeus     Ardidae     Carnivore       Ardea cinerea     Ardeidae     Carnivore     Lahis cristatus     Lanidae     Insectivore       Ardea purpurea     Ardeidae     Carnivore     Lahis cristatus     Nectarinidae     Nectarinidae       Ardea purpurea     Ardeidae     Carnivore     Lonchura atricapita     Estritidiae     Granivore       Ardeo agravii     Ardeidae     Carnivore     Lonchura atricapita     Estritidiae     Granivore       Artena sixua     Ardeidae     Carnivore     Megalama haemacephaia     Megalamide     Onnivore       Bubulcus coromandus     Ardeidae     Carnivore     Megalama haemacephaia     Megalamide     Insectivore       Calandeila brachydacyja     Alaudidae     Insectivore     Merops fontalis     Meropidae     Insectivore       Andou durica     Hirundinidae     Insectivore     Merops orinnalis     Meropidae     Insectivore       Cantorus sinensis     Cuculidae     Carnivore     Miruta finis     Alaudidae     Insectivore       Cantrous isonensis     Cuculidae	Apus nipalensis	Apodidae	Insectivore	Hydrophasianus chirurgus	Jacanidae	Omnivore
Ardea charea Ardeidae Camivore Lanius cristatus Lanius cristatus Lanius cristatus Insectivore   Ardea pupurea Ardeidae Camivore Leptocoma zeylonica Nectarinidae Nectarinidae   Ardeola grayii Ardeidae Camivore Lonchura arizapilla Estrildiae Granivore   Artanus fuscus Artamidae Insectivore Lonchura arizapilla Estrildiae Granivore   Bubulcus coromandus Ardeidae Camivore Megalama haemacephai Megalamidae Granivore   Bubulcus coromandus Ardeidae Camivore Megalama haemacephai Megalamidae Insectivore   Bubulcus coromandus Ardeidae Camivore Merops leschenaulti Meropidae Insectivore   Calandrella brachydachyla Alaudidae Insectivore Merops leschenaulti Meropidae Insectivore   Canivus bangalensis Cuculidae Ornivore Egretta intermedia Ardeidae Carrivore   Carlorus binensis Cuculidae Carnivore Mirota artifitis Alaudidae Insectivore   Carlarduis dubius Charadriidae Carnivore Mirafa cantillans Alaudidae Insectivore   Carlorus binegalensis Cuculidae Carnivore Mirafa cantillans </td <td>Egretta alba</td> <td>Ardeidae</td> <td>Carnivore</td> <td>Ixobrychus cinnamomeus</td> <td>Ardeidae</td> <td>Carnivore</td>	Egretta alba	Ardeidae	Carnivore	Ixobrychus cinnamomeus	Ardeidae	Carnivore
Ardea purpurea     Ardeidae     Camivore     Leptocoma zeytonica     Netarivore       Ardeola grayii     Ardeidae     Camivore     Lonchura atricapilla     Estrididae     Granivore       Ardanus fuscus     Artamidae     Insectivore     Lonchura atricapilla     Estrididae     Granivore       Athene brama     Strigidae     Camivore     Lonchura striata     Estrididae     Granivore       Butoridos commandus     Ardeidae     Camivore     Meggalurus palustris     Loucibulac     Insectivore       Calandrella brachydachyla     Alaudidae     Insectivore     Merops orientalis     Meropidae     Insectivore       Carpinulgus astaticus     Contulidae     Insectivore     Merops orientalis     Meropidae     Insectivore       Cantrous bengalensis     Cuculidae     Camivore     Egretta Intermedia     Ardeidae     Camivore       Charadrius dubus     Charadriudae     Camivore     Miratra attrinis     Alaudidae     Insectivore       Charadrius dubus     Charadriudae     Camivore     Miratra attrinis     Alaudidae     Insectivore       Clanatori jacobrus     Cuculidae	Ardea cinerea	Ardeidae	Carnivore	Lanius cristatus	Laniidae	Insectivore
Ardeola grayii     Ardeidae     Carnivore     Lonchura atricapilia     Estrilidiae     Granivore       Artamus fuscus     Atamidae     Insectivore     Lonchura atricapilia     Estrilidiae     Granivore       Artamus fuscus     Atamidae     Carnivore     Lonchura punctulata     Estrilidiae     Granivore       Bubulos coromandus     Ardeidae     Camivore     Megalaima haemacephal     Megalaimidae     Ornnivore       Bubulos coromandus     Ardeidae     Camivore     Megalaima haemacephal     Megalaimidae     Insectivore       Calandella brachydacyla     Alaudidae     Insectivore     Merops scheanautii     Meropidae     Insectivore       Caprimulgus aslatus     Caulidae     Onnivore     Egretta Intermedia     Ardeidae     Camivore       Cantrous ismensis     Cuculidae     Carnivore     Mirots migrans     Acaidiae     Insectivore       Canadirus dubius     Charadritade     Carnivore     Mirata artifians     Alaudidae     Insectivore       Carniva salaticus     Cacinitidae     Neccinitidae     Canivore     Mirata artifians     Alaudidae     Insectivore	Ardea purpurea	Ardeidae	Carnivore	Leptocoma zeylonica	Nectariniidae	Nectarivore
Artamida     Insectivore     Lonchura punctulata     Estrildidae     Granivore       Athene brama     Strigidae     Camivore     Lonchura striata     Estrildidae     Granivore       Athene brama     Strigidae     Camivore     Megalamia haemacephala     Megalamia     Insectivore     Merops orientalis     Meropidae     Insectivore     Maros philippinus     Meropidae     Insectivore     Maros philippinus     Maros philippinus     Meropidae     Canivore     Maros philippinus     Maros p	Ardeola gravii	Ardeidae	Carnivore	Lonchura atricapilla	Estrildidae	Granivore
Athene brama     Strigidae     Camivore     Lonchura striata     Estididae     Granivore       Bubulcus coromandus     Ardeidae     Camivore     Megalaima haemacephaia     Megalaima demacephaia     Megalaima haemacephaia     Megalaima haemacephaia     Megalaima haemacephaia     Megalaima haemacephaia     Meropisae     Insectivore       Calandella brachydacyla     Alaudidae     Insectivore     Merops feschenauti     Meropidae     Insectivore       Antonida daurica     Hirundinidae     Insectivore     Merops orientalis     Merops orientalis     Merops orientalis     Merops orientalis     Ardeidae     Insectivore       Centropus bengalensis     Cuculidae     Carnivore     Merops orientalis     Ardeidae     Carnivore       Candruis     Charadriis     Carnivore     Miruta antitians     Alaudidae     Insectivore       Charadrius dubus     Charadriidae     Carnivore     Mirata cantilians     Alaudidae     Insectivore       Cinorus anacrurus     Accipitridae     Carnivore     Matailla madaraspatansis     Matailidae     Insectivore       Cinardior iacobis     Cuculidae     Onnivore     Mustailia natemacephaia <td>Artamus fuscus</td> <td>Artamidae</td> <td>Insectivore</td> <td>Lonchura punctulata</td> <td>Estrildidae</td> <td>Granivore</td>	Artamus fuscus	Artamidae	Insectivore	Lonchura punctulata	Estrildidae	Granivore
Bubulas coromandus     Ardeidae     Camivore     Megalarra haernacephaia     Meropidae     Insectivore       Butorides striata     Ardeidae     Insectivore     Merops leschenaulti     Meropidae     Insectivore       Caprimulgus astaticus     Caprimulgidae     Insectivore     Merops printalis     Meropidae     Insectivore       Centropus bengalensis     Cuculidae     Omnivore     Egretta intermedia     Ardeidae     Carnivore       Carniva dubis     Cerylidae     Carnivore     Mirafra afinis     Alaudidae     Insectivore       Charadrius dubius     Charadriidae     Carnivore     Mirafra afinis     Alaudidae     Insectivore       Cincoli apiscopus     Ciconia deiscopus     Ciconidae     Carnivore     Mirafra arythoptera     Alaudidae     Insectivore       Cisocia dunoidis     Cistocildae     Insectivore     Mirafra arythoptera     Alaudidae     Insectivore       Cisocia burgistasiaficus     Nuscicap	Athene brama	Strigidae	Carnivore	Lonchura striata	Estrildidae	Granivore
Butorides striata     Ardeidae     Camivore     Megalurus palustrisis     Locusilidae     Insectivore       Calandrella brachydachyla     Alaudidae     Insectivore     Merops leschenaulti     Meropidae     Insectivore       Calandrella brachydachyla     Alaudidae     Insectivore     Merops orianialis     Meropidae     Insectivore       Hirundo daurica     Hirundinidae     Insectivore     Merops philippinus     Meropidae     Insectivore       Centropus bengalensis     Cuculidae     Carnivore     Egretta Intermedia     Ardeidae     Carnivore       Centropus binensis     Cuculidae     Carnivore     Mirus migrans     Accipitridae     Omnivore       Charadrius dubus     Charadriidae     Carnivore     Mirafra afinis     Alaudidae     Insectivore       Ciconia episcopus     Ciconiidae     Carnivore     Mirafra afinis     Alaudidae     Insectivore       Cistola juncidis     Cistoclidae     Carnivore     Motacilla cinerea     Motacilidae     Insectivore       Clamator jacobinus     Cuculidae     Onnivore     Matacila afinas     Alaudidae     Insectivore       Clamat	Bubulcus coromandus	Ardeidae	Carnivore	Megalaima haemacephala	Megalaimidae	Omnivore
Calandrella brachydacyja     Alaudidae     Insectivore     Merops leschenautii     Meropidae     Insectivore       Caprimulgus asiaticus     Caprimulgudae     Insectivore     Merops orientalis     Meropidae     Insectivore       Caprimulgus asiaticus     Caprimulgudae     Insectivore     Merops orientalis     Meropidae     Insectivore       Centropus bengalensis     Cuculidae     Ornivore     Egretta Intermedia     Ardeidae     Carnivore       Cantadrus     Charadrus     Carnivore     Merops ingrans     Acquidiae     Insectivore       Charadrus     Catadrus     Carnivore     Mirafra cantillans     Alaudidae     Insectivore       Charadrus     Alaudidae     Cansivore     Mirafra cantillans     Alaudidae     Insectivore       Charadrus     Actalitidae     Nectainidae     Cansivore     Mirafra cantillans     Alaudidae     Insectivore       Clonaia spiacobus     Cuclidae     Insectivore     Mirafra cantillans     Alaudidae     Insectivore       Clamator jacobus     Cuclidae     Ornivore     Mirafra cantillans     Muscicapidae     Insectivore	Butorides striata	Ardeidae	Carnivore	Megalurus palustris	Locustellidae	Insectivore
Caprimulgus aslaticus     Caprimulgulade     Insectivore     Merops orientalis     Meropidae     Insectivore       Hirundo daurica     Hirundinidae     Insectivore     Merops orientalis     Merops orientalis     Merops orientalis     Merops orientalis     Merops orientalis     Carrivore       Centropus bengalensis     Cuculidae     Carnivore     Egretta intermedia     Ardeidae     Carnivore       Centropus sinensis     Cuculidae     Carnivore     Milvas migrans     Acacipitridae     Ornnivore       Charadrius dublus     Charadridae     Carnivore     Mirafra affinis     Alaudidae     Insectivore       Cinnyria saitatus     Nectarinore     Mirafra antilians     Alaudidae     Insectivore       Cincoli age orientalis     Ciscola punctifica     Cistocal functifica     Metodaria     Matodiae     Insectivore       Cistocal functifica     Cistocal functifica     Conscitade     Ornnivore     Motacilla cinerea     Motacillade     Insectivore       Cistocal functifica     Counbidae     Ornnivore     Motacilla cinerea     Muscicapidae     Insectivore       Carauta piacobinus     Cuculidae     Ornni	Calandrella brachydactyla	Alaudidae	Insectivore	Merops leschenaulti	Meropidae	insectivore
Hirundo daurica     Hirundinidae     Insectivore     Merops philippirus     Meropidae     Insectivore       Centropus bengalensis     Cuculidae     Omnivore     Egretta intermedia     Ardeidae     Carnivore       Centropus sinensis     Cuculidae     Carnivore     Metopidius indicus     Jacanidae     Carnivore       Centropus sinensis     Cuculidae     Carnivore     Mitrus migrans     Acoleitae     Carnivore       Canadritida     Carnivore     Mirafra cantilians     Alaudidae     Insectivore       Cicron agrissiaticus     Nectarivica     Carnivore     Mirafra cantilians     Alaudidae     Insectivore       Circus macronuus     Accipitridae     Carnivore     Matacilla cherea     Motacilla de Insectivore       Camatori jacobius     Cuculidae     Onnivore     Muscinargata duurica     Muscinargata     Nectarivore       Conzaias benghalensis     Coraciidae     Onnivore     Muscinargata duurica     Muscinargata     Nectarivore       Coracias benghalensis     Coraciidae     Omnivore     Oriolus oriolus     Oriolae     Omnivore       Coracias benghalensis     Coraciidae	Caprimulgus asiaticus	Caprimulgidae	Insectivore	Merops orientalis	Meropidae	Insectivore
Centropus bengatensis     Cuculidae     Ormivore     Egretta intermedia     Addada     Carnivore       Centropus sinensis     Cuculidae     Carnivore     Metopidius indicus     Jacanidae     Carnivore       Centropus sinensis     Cuculidae     Carnivore     Metopidius indicus     Jacanidae     Carnivore       Charadnitas dublus     Charadnitae     Carnivore     Mirafra affinis     Alaudiae     Insectivore       Charadnitas dublus     Charadnitae     Carnivore     Mirafra affinis     Alaudiae     Insectivore       Cinno piscopus     Ciconidae     Carnivore     Mirafra antilans     Alaudiae     Insectivore       Cistopia juncidis     Cistopia juncidis     Cistopia juncidis     Cistopia funcidis	Hirundo daurica	Hirundinidae	Insectivore	Merops philippinus	Meropidae	Insectivore
Centropus sinensis     Cuculidae     Carnivore     Metopidius indicus     Jacanidae     Carnivore       Caryle rudis     Charadriidae     Carnivore     Milvus migrans     Acoipitridae     Omnivore       Charadriida dubius     Charadriidae     Carnivore     Milrafra affinis     Alaudidae     Insectivore       Ciconia episcopus     Ciconiidae     Carnivore     Mirafra affinis     Alaudidae     Insectivore       Cinnyis asiaticus     Nectarinidae     Carnivore     Mirafra affinis     Alaudidae     Insectivore       Cisticola juncidis     Cistoclidae     Carnivore     Matacilla cinerea     Motacillade     Carnivore       Clamator jacobinus     Cuculidae     Onnivore     Muscilapidae     Muscilapidae     Carnivore       Columbia livia     Columbidae     Onnivore     Muscilapidae     Insectivore     Cindivis Icianius     Nectarinivore       Coracina melanoptera     Caradidae     Onnivore     Onolus oriolus     Oriolidae     Omnivore       Coracina melanoptera     Carvidae     Onnivore     Oriolus oriolus     Cisticolidae     Insectivore       Coracin	Centropus bengalensis	Cuculidae	Omnivore	Egretta intermedia	Ardeidae	Carnivore
Caryle rudis     Carylidae     Carnivore     Milvus migrans     Acoptindae     Onnivore       Charadrius dubius     Charadrius dubius     Charadrius Carnivore     Mirafa affilis     Alaudidae     Insectivore       Charadrius dubius     Charadrius     Cannivore     Mirafa cantillans     Alaudidae     Insectivore       Cinoni agisacous     Ciconi dae     Carnivore     Mirafa cantillans     Alaudidae     Insectivore       Cinurs macronurs     Accipitridae     Nectaninidae     Nectaninidae     Motacilla rudaraspatensis     Motacillidae     Insectivore       Calmator jacobrus     Cuclidae     Insectivore     Muscinapidae     Muscinapidae     Insectivore       Columbal ivia     Columbidae     Onnivore     Muscinapidae     Muscinapidae     Insectivore       Coracias banghalansis     Coaciidae     Onnivore     Oriolus oriolus     Oriolae     Insectivore       Coracias banghalansis     Coaciidae     Onnivore     Oriolus oriolus     Oriolae     Onnivore       Coracias banghalansis     Coaciidae     Onnivore     Oriolus oriolus     Oriolae     Onnivore	Centropus sinensis	Cuculidae	Carnivore	Metopidius indicus	Jacanidae	Carnivore
Charadnidae     Camivore     Mirafra affinis     Alaudicae     Insectivore       Ciconia episcopus     Ciconidae     Cannivore     Mirafra cantilians     Alaudicae     Insectivore       Ciconia episcopus     Ciconidae     Cannivore     Mirafra cantilians     Alaudicae     Insectivore       Cinnyria salafcus     Nectarinidae     Cannivore     Mirafra cantilians     Alaudicae     Insectivore       Cinus macrourus     Accipitridae     Camivore     Mirafra enritina de printoria     Motacilia cinerea     Motacilidae     Camivore       Calumbida     Cistocial juncio     Cistocial juncio     Miscitaga dauncia     Muscicapidae     Insectivore       Conscina benghalensis     Coracidae     Onnivore     Myrctiorax nyctioorax     Ardeidae     Camivore       Coracias benghalensis     Coracidae     Onnivore     Ortholorus sutorius     Cisticolai unove     Ortholorus sutorius     Cisticolai unove     Ortholorus sutorius     Cisticolai cinnore     Canivore       Coracias benghalensis     Corvidae     Onnivore     Pasaer domaticus     Pasaeridae     Granivore       Carvius saplenders     Corvidae	Ceryle rudis	Cerylidae	Carnivore	Milvus migrans	Accipitridae	Omnivore
Ciconi apiscopus     Ciconidae     Carnivore     Mirafra cantilians     Alaudicae     Insactivore       Cinnyria salaticus     Nectarivore     Mirafra cantilians     Alaudicae     Insactivore       Cinnyria salaticus     Nectarivore     Mirafra enrythroptera     Alaudicae     Insactivore       Cinus macrourus     Aciopitridae     Carnivore     Mitafra enrythroptera     Madcillidae     Insactivore       Cistocia juncitis     Cistocidae     Insectivore     Mitafra enrythroptera     Muscicapidae     Insectivore       Columba ivia     Columbidae     Onnivore     Muscicapidae     Onecipidae     Cannivore       Coracias benghalensis     Coraciidae     Ornnivore     Oriolus oriolus     Oriolidae     Onnivore       Coracias benghalensis     Coraciidae     Onnivore     Oriolus oriolus     Oriolae     Onnivore       Corvus macorhynchos     Corvidae     Onnivore     Oriolus oriolus     Oriolae     Onnivore       Corus macorhynchos     Corvidae     Onnivore     Plasser domesitus     Plasainidae     Insectivore       Orpsitrus balasiensis     Apodidae     Insectivore <td>Charadrius dubius</td> <td>Charadriidae</td> <td>Carnivore</td> <td>Mirafra affinis</td> <td>Alaudidae</td> <td>Insectivore</td>	Charadrius dubius	Charadriidae	Carnivore	Mirafra affinis	Alaudidae	Insectivore
Cinnyris asiaticus     Nectainiidae     Nectainiidae     Nectainiidae     Nectainiidae     Nectainiidae     Nectainiidae     Insectivore       Cincus macrourus     Accipitridae     Camivore     Motacilla cinerea     Motacillidae     Camivore       Cilcola juncidis     Cistoola juncidis     Cistoola juncia     Motacilla cinerea     Motacillidae     Insectivore       Clamato rizotoria     Cistoola juncia     Ostoola     Muscicapa daurica     Muscicapidae     Insectivore       Columba liva     Oumbidae     Onmivore     Myscicapa daurica     Muscicapidae     Insectivore       Coracitas benghalensis     Coracidae     Ornnivore     Myscicarax nyscicorax     Acdea     Camivore       Coracita melanoptra     Campephagidae     Insectivore     Ortholoraus sutorius     Cistola junci     Omnivore       Coracita melanoptra     Campephagidae     Insectivore     Passer donesticus     Passeridae     Granivore       Corusia selanoptra     Caudiva     Ornnivore     Passer donesticus     Passeridae     Granivore       Corusia selanopta     Caudiva     Insectivore     Passer donesticus     Pasa	Ciconia episcopus	Ciconiidae	Carnivore	Mirafra cantillans	Alaudidae	Insectivore
Circus macrourus     Accipitridae     Carnivore     Motacilla cinerea     Motacilla cinerea     Motacillade     Carnivore       Cisicola juncidis     Cisticolidae     Insectivore     Motacilla cinerea     Motacillade     Insectivore       Cisticola juncidis     Cisticolidae     Insectivore     Motacilla madaraspatensis     Muscicapidae     Insectivore       Columba irizacobinus     Cuculidae     Onnivore     Muscicapidae     Muscicapidae     Insectivore       Columba iriza     Columbidae     Onnivore     Mycteria leucocephala     Ciolidas     Carnivore       Coracina melanoptera     Caracidae     Onnivore     Oriolus oriotus     Oriolidae     Onnivore       Corus macrohynchos     Corvidae     Onnivore     Oriolus oriotus     Cisticolidae     Onnivore       Corus macrohynchos     Corvidae     Onnivore     Oriolus oriotus     Passeridae     Graivore       Corus macrohynchos     Corvidae     Onnivore     Passer domesticus     Pasaridae     Insectivore       Corus macrohynchos     Coculidae     Granivore     Phalacrocorax cabo     Phalacrocoracidae     Carnivore	Cinnyris asiaticus	Nectariniidae	Nectarivore	Mirafra erythroptera	Alaudidae	Insectivore
Cisticolidae     Insectivore     Motacilla madanspatensis     Motacilla madanspatensis     Motacilla madanspatensis     Motacilla madanspatensis     Motacilla madanspatensis     Motacilla madanspatensis     Muscicapidae     Insectivore       Calmator jacobinus     Coulnidae     Omnivore     Muscicapidae     Muscicapidae     Nuscicapidae     Insectivore     Pasor ofisitus     Pasianidae     Omnivore     Opaio ortistus     Pasianidae     Omnivore     Pasor ofisitus     Pasianidae     Omnivore     Pasor ofisitus     Pasianidae     Omnivore     Pasor ofisitus     Pasianidae     Omnivore     Pasor	Circus macrourus	Accipitridae	Carnivore	Motacilla cinerea	Motacillidae	Carnivore
Clamator jacobirus     Cuculidae     Ornivore     Musiciapa daurrica     Musiciapidae     Insectivore       Columbal ivia     Columbidae     Omnivore     Mysteria leucocephala     Ciconidae     Carrivore       Columbal ivia     Columbidae     Omnivore     Mysteria leucocephala     Ciconidae     Carrivore       Copsychus saularis     Musicicapidae     Ornivore     Cimyris lotanius     Nectariniidae     Netrativore       Coracias benghalensis     Coracidae     Ornivore     Oriolorax nycticorax     Ardidae     Camivore       Coracias pelnanoptra     Convidae     Ornivore     Ortotomus sutorius     Cistolidae     Insectivore       Caruus macorhynchos     Corvidae     Ornnivore     Pasaer domesticus     Pasaeridae     Granivore       Caruus signendens     Coulidae     Ornnivore     Pasaer domesticus     Phasianidae     Ornivore       Dendroita vagabunda     Covidae     Ornnivore     Pasaer domesticus     Phasiarcooracidae     Carnivore       Dendroita vagabunda     Covidae     Ornnivore     Phalarcoorax fuscicolis     Phalarcooracidae     Carnivore       Dicaeum	Cisticola juncidis	Cisticolidae	Insectivore	Motacilla madaraspatensis	Motacillidae	Insectivore
Columbida     Onlinivore     Mysteria leucocephala     Colicidae     Carmivore       Copsychus saularis     Muscicapidae     Omnivore     Cinnyis Icianius     Nectarinidae     Nectariniore       Coracias benghalensis     Coracididae     Omnivore     Mysteria leucocephala     Cionius     Nectarinidae     Nectarinidae       Coracias melanoptera     Campephagidae     Insectivore     Ofolds oriolus     Ofoldae     Omnivore       Corus macorhynchos     Corvidae     Omnivore     Ortolum sutorius     Disturbuista     Disturbuista     Cistucolidae     Omnivore       Corusus asplendens     Corvidae     Omnivore     Plasar domesitus     Plasaridae     Ganivore       Cypsiurus balasiensis     Apodidae     Insectivore     Phalacrocorax darbo     Phalacrocorax darbo     Phalacrocorax darbo     Phalacrocorax darbo     Dendrocypai seconarbo     Cialidae     Cinvore       Dicaeum minulum     Dicaeidae     Nectrivore     Phylloscopus affinis     Phylloscopidae     Insectivore       Dicaeum mythrorhynchos     Dicaeidae     Nectrivore     Phylloscopus affinis     Phylloscopidae     Insectivore	Clamator jacobinus	Cuculidae	Omnivore	Muscicapa dauurica	Muscicapidae	Insectivore
Capsychus saularis     Muscicapidae     Omnivore     Cinnyris Iclanius     Netatrivore     Norticorax     Ardeidae     Netatrivore       Coracias benghalensis     Coracidae     Omnivore     Nycticorax     Ardeidae     Camivore       Coracias benghalensis     Caracidae     Omnivore     Nycticorax     Ardeidae     Camivore       Coracias melanoptra     Campephagidae     Insectivore     Ortholornus subrisus     Cistolidae     Insectivore       Corvus splendens     Corvidae     Ornnivore     Passar domesticus     Passaridae     Granivore       Cuculus micropterus     Cuculidae     Ornnivore     Pavo cristatus     Phalancocoracidae     Carnivore       Dendrocita vagabunda     Corvidae     Onnivore     Phalacrocorax carbo     Phalacrocoracidae     Carnivore       Dendrocita vagabunda     Cuculidae     Granivore     Phalacrocorax niger     Phalacrocoracidae     Carnivore       Dendrocita vagabunda     Cuculidae     Nectarivore     Phylloscopus atfinis     Phyloscopidae     Insectivore       Dicaeum minullum     Dicaeidae     Nectarivore     Phylloscopus atfinis     Phyloscopidae </td <td>Columba livia</td> <td>Columbidae</td> <td>Omnivore</td> <td>Mycteria leucocephala</td> <td>Ciconiidae</td> <td>Carnivore</td>	Columba livia	Columbidae	Omnivore	Mycteria leucocephala	Ciconiidae	Carnivore
Coracitas benghalensis     Coracidae     Onnivore     Nychorax nychorax     Addea     Camivore       Coracina melanoptera     Campephagidae     Insectivore     Oriolus oriotus     Oriolidae     Onnivore       Corus macrohynchos     Convidae     Onnivore     Oriolus oriotus     Oriolidae     Onnivore       Corus macrohynchos     Convidae     Onnivore     Oriolus oriotus     Cisticolidae     Insectivore       Corus macrohynchos     Convidae     Onnivore     Plasser domesticus     Plassinidae     Granivore       Cuculis micropherus     Cuculidae     Onnivore     Plasor domacrosticus     Plasainidae     Insectivore       Dendrocyna javanica     Cuculidae     Granivore     Phalacrocorax fusicolits     Phalacrocoracidae     Carnivore       Dicaeum agile     Dicaeidae     Nectarivore     Phalacrocorax fusicolits     Phalacrocoracidae     Carnivore       Dicaeum agile     Dicaeidae     Nectarivore     Phylloscopus afirin     Phylloscopidae     Insectivore       Dicaeum minulum     Dicaeidae     Nectarivore     Phylloscopus afirin     Phylloscopidae     Insectivore	Copsychus saularis	Muscicapidae	Omnivore	Cinnyris lotenius	Nectariniidae	Nectarivore
Coracina melanoptera     Campephagidae     Insectivore     Oriolus oriolus     Oriolus oriolus     Oriolus oriolus     Oriolus oriolus     Oriolus oriolus     Orinivore     Ornivore       Corvus splendens     Corvidae     Ornnivore     Orthotornus sutorius     Cisticolidae     Insectivore       Corvus splendens     Corvidae     Ornnivore     Passor dremsticus     Passeridae     Granivore       Cuculis micropterus     Cuculidae     Ornnivore     Pavo cristatus     Phasinidae     Ornnivore       Oppsiurus balasiensis     Apodidae     Insectivore     Phalacrocorax carbo     Phalacrocoracidae     Carrivore       Dendrocita vagabunda     Coculidae     Granivore     Phalacrocorax carbo     Phalacrocoracidae     Carrivore       Dendrocita vagabunda     Cuculidae     Granivore     Phalacrocorax carbo     Phalacrocoracidae     Carrivore       Dendrocita vagabunda     Cuculidae     Granivore     Phalacrocorax carbo     Phalacrocoracidae     Carrivore       Dicaeum agriu     Dicaeidae     Nectarivore     Phylloscopus affinis     Phylloscopidae     Insectivore       Dicarus aerues     Dicruridae <td>Coracias benghalensis</td> <td>Coraciidae</td> <td>Omnivore</td> <td>Nycticorax nycticorax</td> <td>Ardeidae</td> <td>Carnivore</td>	Coracias benghalensis	Coraciidae	Omnivore	Nycticorax nycticorax	Ardeidae	Carnivore
Corvus maconfrynchos     Corvidae     Omnivore     Ortholomus sutorius     Cisticula     Insectivore       Corvus splendens     Corvidae     Omnivore     Passer domesticus     Passeridae     Granivore       Corvus splendens     Coucilia     Omnivore     Passer domesticus     Passeridae     Granivore       Cuculus micropterus     Cuculidae     Omnivore     Passer domesticus     Phasianidae     Omnivore       Cypsiums batasiensis     Apodidae     Insectivore     Pericrocotus cinnamomeus     Ompehpagidae     Insectivore       Dendrocita vagabunda     Corvidae     Granivore     Phalacrocorax fuscicollis     Phalacrocoracidae     Carrivore       Dendrocita vagabunda     Cuculidae     Granivore     Phalacrocorax fuscicollis     Phalacrocoracidae     Carrivore       Dicaeum agile     Dicaeidae     Nectarivore     Phylloscopus affinis     Phylloscopidae     Insectivore       Dicaeum minullum     Dicaeidae     Nectarivore     Phylloscopus affinis     Phylloscopidae     Insectivore       Dicrurus caerulescens     Dicruridae     Insectivore     Phylloscopus tacoracidaes     Insectivore	Coracina melanoptera	Campephagidae	Insectivore	Oriolus oriolus	Oriolidae	Omnivore
Corvus splendens     Corvidae     Omnivore     Passer domesticus     Passeridae     Granivore       Cuculus micropterus     Cuculidae     Omnivore     Pavor constatus     Phasianidae     Omnivore       Cypsiuns balasiensis     Apodidae     Insectivore     Phalacrocoratus ciabus     Phalacrocoratus     Campephagidae     Insectivore       Dendrocypa javanica     Cucildae     Granivore     Phalacrocoratus ciabus     Phalacrocoratus     Camivore       Dicacum aglie     Dicaeidae     Nectarivore     Phalacrocoratus     Phalacrocoratus     Camivore       Dicaeum aglie     Dicaeidae     Nectarivore     Phalacrocoratus     Phalacrocoratus     Camivore       Dicaeum minullum     Dicaeidae     Nectarivore     Phylloscopus afinis     Phylloscopudae     Insectivore       Dicrurus aeneus     Dicruridae     Insectivore     Phylloscopus trochioldes     Phylloscopidae     Insectivore       Dicrurus aenus     Dicruridae     Insectivore     Phylloscopus trochioldes     Phyloscopidae     Insectivore       Dicrurus aenus     Dicruridae     Omnivore     Phyloscopidae     Insectivore     Dipusto	Corvus macrorhynchos	Corvidae	Omnivore	Orthotomus sutorius	Cisticolidae	Insectivore
Cucultas micropterus     Cucultas     Onnivore     Pavo cristatus     Phasimidae     Onnivore       Orpsiurus balasiensis     Apodidae     Insectivore     Pericrocotts cinnamorneus     Campephagidae     Insectivore       Dendrocita vagabunda     Corvidae     Onnivore     Phalacrocorax carbo     Phalacrocoracidae     Carnivore       Dendrocita vagabunda     Cucultas     Granivore     Phalacrocorax carbo     Phalacrocoracidae     Carnivore       Dendrocita vagabunda     Cucultas     Granivore     Phalacrocorax nager     Phalacrocoracidae     Carnivore       Dicaeum enfithentynchos     Dicaeidae     Nectarivore     Phylloscopus affinis     Phylloscopidae     Insectivore       Dicaeum enfithentynchos     Dicaeidae     Nectarivore     Phylloscopus fuscatus     Phylloscopidae     Insectivore       Dicarus acerulescens     Dicruridae     Onnivore     Phylloscopus tochioldes     Phyloscopidae     Insectivore       Dicrurus caerulescens     Dicruridae     Onnivore     Ploeaus philippinus     Ploediae     Onnivore       Dicrurus macrocercus     Dicruridae     Onnivore     Ploeaus philippinus     Ploediae	Corvus splendens	Corvidae	Omnivore	Passer domesticus	Passeridae	Granivore
Cypsiums balasiensis     Apodidae     Insectivore     Periorocotus cinnamomeus     Campephagidae     Insectivore       Dendrocyna javanica     Corvidae     Omnivore     Phalacrocorax carbo     Phalacrocorax cidao     Phalacrocorax cidao     Carvivore       Dendrocyna javanica     Cuculidae     Granivore     Phalacrocorax fusciolits     Phalacrocoracidae     Carvivore       Dicaeum agile     Dicaeidae     Nectarivore     Phalacrocorax fusciolits     Phalacrocoracidae     Carvivore       Dicaeum agile     Dicaeidae     Nectarivore     Phylloscopus afinis     Phylloscopuidae     Insectivore       Dicaeum anninulum     Dicaeidae     Nectarivore     Phylloscopus afinis     Phylloscopidae     Insectivore       Dicrurus aeneus     Dicruridae     Insectivore     Phylloscopus trochioldes     Phylloscopidae     Insectivore       Dicrurus aeneus     Dicruridae     Insectivore     Plegadia faicinelius     Threskiomihidae     Carvivore       Dicrurus aenues     Dicruridae     Omnivore     Plegadia faicinelius     Threskiomihidae     Carvivore       Dinopium benghalense     Picidae     Omnivore     Potoeus philip	Cuculus micropterus	Cuculidae	Omnivore	Pavo cristatus	Phasianidae	Omnivore
Dendrocitta vagabunda     Corvidae     Omnivore     Phalacrocorax carbo     Phalacrocoracidae     Carnivore       Dendrocygna javanica     Cucuidae     Granivore     Phalacrocorax carbo     Phalacrocoracidae     Carnivore       Dicaeura gile     Dicaeidae     Nectarivore     Phalacrocorax inger     P	Cypsiurus balasiensis	Apodidae	Insectivore	Pericrocotus cinnamomeus	Campephagidae	Insectivore
Dendrocygna javanica     Cuculidae     Granivore     Phalacrocorax fuscicollis     Phalacrocoracidae     Carnivore       Dicaeum agile     Dicaeidae     Netatrivore     Phalacrocorax fuscicollis     Phalacrocoracidae     Carnivore       Dicaeum agile     Dicaeidae     Netatrivore     Phylloscopus affinis     Phylloscopicae     Insectivore       Dicaeum minullum     Dicaeidae     Netatrivore     Phylloscopus saffinis     Phylloscopidae     Insectivore       Dicrurus acerulescens     Dicruridae     Omnivore     Phylloscopus fuscalus     Phylloscopidae     Insectivore       Dicrurus acerulescens     Dicruridae     Onnivore     Pleceus philippinus     Ploceidae     Omnivore       Dinopium benghalense     Picidae     Omnivore     Porceus philippinus     Ploceidae     Omnivore	Dendrocitta vagabunda	Corvidae	Omnivore	Phalacrocorax carbo	Phalacrocoracidae	Carnivore
Dicaeum agile     Dicaeidae     Nectarivore     Phalacrocorax niger     Phalacrocoracidae     camivore       Dicaeum arythrothynchos     Dicaeidae     Nectarivore     Phylloscopus afinins     Phylloscopidae     Insectivore       Dicaeum arythrothynchos     Dicaeidae     Nectarivore     Phylloscopus fuscatus     Phylloscopidae     Insectivore       Dicruns aereus     Dicrunidae     Omnivore     Phylloscopus trachiloides     Phylloscopidae     Insectivore       Dicruns caerulescens     Dicrunidae     Insectivore     Phegadis falcinellus     Threskorinthidae     Carnivore       Dicruns caerulescens     Dicrunidae     Omnivore     Phoecus philippinus     Ploceidae     Omnivore       Dicruns macrocercus     Dicrunidae     Omnivore     Polytoesopidae     Carnivore	Dendrocygna javanica	Cuculidae	Granivore	Phalacrocorax fuscicollis	Phalacrocoracidae	Carnivore
Dicaeum enythrorhynchos     Dicaeidae     Nectarivore     Phylloscopus affinis     Phylloscopidae     Insectivore       Dicaeum minulum     Dicaeidae     Nectarivore     Phylloscopus fuzicatus     Phylloscopidae     Insectivore       Dicrurus acenues     Dicruridae     Onnivore     Phylloscopus fuzicatus     Phylloscopidae     Insectivore       Dicrurus acenulescens     Dicruridae     Insectivore     Phylloscopus fuzicatus     Threskornithidae     Camivore       Dicrurus macrocercus     Dicruridae     Omnivore     Ploceus philippinus     Ploceidae     Omnivore       Dionjum benghalense     Picidae     Omnivore     Portugo portugo     Railidae     Carnivore	Dicaeum agile	Dicaeidae	Nectarivore	Phalacrocorax niger	Phalacrocoracidae	carnivore
Dicaeidae     Nectarivore     Phylloscopus fuxeatus     Phylloscopidae     Insectivore       Dicrurus aeneus     Dicruridae     Ornnivore     Phylloscopus trochiloides     Phylloscopidae     Insectivore       Dicrurus caerulescens     Dicruridae     Insectivore     Piegadis falcinellus     Threskiomitidae     Camivore       Dicrurus caerulescens     Dicruridae     Ornnivore     Piegadis falcinellus     Threskiomitidae     Camivore       Diopium benghalense     Picidae     Ornnivore     Poceus philippinus     Piocelidae     Omnivore	Dicaeum erythrorhynchos	Dicaeidae	Nectarivore	Phylloscopus affinis	Phylloscopidae	Insectivore
Dicrurus aeneus     Dicruridae     Omnivore     Phylloscopus trochiloides     Phylloscopidae     Insectivore       Dicrurus caerulescens     Dicruridae     Insectivore     Plegadis falcinellus     Threskiomithidae     Carnivore       Dicrurus macrocercus     Dicruridae     Omnivore     Ploceus philippinus     Ploceidae     Omnivore       Dicruine and phalense     Picidae     Omnivore     Porphyrio porphyrio     Ralildae     Carnivore	Dicaeum minullum	Dicaeidae	Nectarivore	Phylloscopus fuscatus	Phylloscopidae	Insectivore
Dicrurus caerulescens Dicruridae Insectivore Plegadis falcinellus Threskiomithidae Camivore Dicrurus macrocercus Dicruridae Omnivore Ploceus philippinus Plocelidae Omnivore Dinojum benghalense Picidae Omnivore Porphyrio porphyrio Ralildae Camivore	Dicrurus aeneus	Dicruridae	Omnivore	Phylloscopus trochiloides	Phylloscopidae	Insectivore
Dicrurius macrocercus Dicruridae Omnivore Ploceus philippinus Ploceidae Omnivore Dinopium benghalense Picidae Omnivore Porphyrio porphyrio Rallidae Carnivore	Dicrurus caerulescens	Dicruridae	Insectivore	Plegadis falcinellus	Threskiornithidae	Carnivore
Dinopium benghalense Picidae Omnivore Porphyrio porphyrio Rallidae Carnivore	Dicrurus macrocercus	Dicruridae	Omnivore	Ploceus philippinus	Ploceidae	Omnivore
	Dinopium benghalense	Picidae	Omnivore	Porphyrio porphyrio	Rallidae	Carnivore

Species	Family	Foraging Guild	Species	Family	Foraging Guild
Porzana fusca	Rallidae	Omnivore	Temenuchus pagodarum	Sturnidae	Omnivore
Prinia inornata	Cisticolidae	Insectivore	Sturnus roseus	Sturnidae	Omnivore
Prinia socialis	Cisticolidae	Insectivore	Surniculus lugubris	Cuculidae	Omnivore
Psittacula krameri	Psittacidae	Frugivore	Tachybaptus ruficollis	Podicipedidae	Carnivore
Pycnonotus cafer	Pycnonotidae	Omnivore	Tephrodornis	Prionopidae	Insectivore
Pycnonotus luteolus	Pycnonotidae	Omnivore	pondicerianus		
Recurvirostra avosetta	Recurvirostridae	Carnivore	Terpsiphone paradisi	Monarchidae	Insectivore
Saxicola caprata	Muscicapidae	Insectivore	Tringa stagnatilis	Scolopacidae	Insectivore
Saxicoloides fulicatus	Muscicapidae	Omnivore	Turdoides affinis	Timaliidae	Omnivore
Streptopelia chinensis	Columbidae	Omnivore	Tyto alba	Tytonidae	Carnivore
Sterna hirundo	Sternidae	Carnivore	Upupa epops	Upupidae	Omnivore
Streptopelia senegalensis	Columbidae	Omnivore	Vanellus indicus	Charadriidae	Carnivore
Streptopelia decaocto	Columbidae	Granivore	Vanellus malabaricus	Charadriidae	Carnivore
Streptopelia orientalis	Columbidae	Omnivore	Zoothera citrina	Turdidae	Omnivore

Table 2: List of bird species recorded based on their foraging guild (contd.)

for Prinia socialis, Phylloscopus trochiloides, P. affinis, Orthotomus sutorius and Streptopelia chinensis.

Along the urban matrix, species concentrate more in the urban fringe as it provides a unique corridor and varied landscapes for different species of birds. Among urban birds, the House Sparrow Passer domesticus was the most effected by urbanisation. House Sparrow populations were recorded in 12 urban (Fig. 4), 4 suburban and 20 rural locations. The highest population of House Sparrow was recorded in the suburban regions of Tiruchirappalli, in and around areas of Panjapur along the Madurai bypass. Along the gradient, House Sparrows were mostly seen associated with houses with tiled and thatched roofs, in and around rice mills and agricultural landscapes. The mean population of House Sparrow recorded was urban 9, suburban 114, and rural 36.

# DISCUSSION

The results show significant difference in the diversity indexes of species occupying the urban-rural gradient. This



Fig. 5: House Sparrows inhabiting 12 selected locations within the urban landscape



Fig. 6: Nesting of House Sparrows in holes in walls of highway flyovers

can be attributed to the varied landscapes and land use patterns available to birds including agriculture fields, wetlands, wastelands, and plantations. Though diversity is less in urban areas, the abundance of species occupying the urban matrix is higher and increases with urbanisation and is in accordance with other studies (Beissinger and Osborne 1982; Chace and Walsh 2006; Clergeau et al. 1998; Emlen 1974; Shochat 2004). Omnivorous species show higher abundance in the urban matrix, leaving less resources to birds from other foraging guilds. Diversity reached a peak at moderate levels of urbanisation and this was revealed in other studies (Blair 1996; 2001; Crooks et al. 2004; Jokimäki and Suhonen 1993). But, there was no significant difference in niche breadth of birds occupying different landscapes along an urban-rural gradient. as species tend to exploit a wider area based on resource availability in the urban, suburban, and rural regions. Higher abundance of omnivorous species in urban settings can be correlated to the abundant resources and less predation in the urban matrix, which is supported by several studies (Beissinger and Osborne 1982; Chace and Walsh 2006; Emlen 1974; Kluza et al. 2000; Lancaster and Rees 1979; Mills et al. 1989). Species

diversity in the urban landscape is significantly composed by the edge species like Black Drongo, Indian Roller, Indian Pond-Heron, Great Egret, Little Egret, Eastem Cattle-Egret, Indian Bush Lark that occupy the urban fringes. This study proves that urbanisation has a negative impact on species richness, and is supported by other studies by Stratford and Robinson (2005).

Among the common urban birds, Passer domesticus is the most affected, with only a few individuals inhabiting select locations within the city. Their decline can be attributed to loss of food due to modernised granaries, decline of insect prey and most importantly loss of nesting sites. Although decline is noticed overall in the study area, a few sparrow friendly habitats occur along the urban fringes and rural matrix, particularly in the proximity of rice mills, thatched huts, and more interestingly in drainage holes of highway flyovers in the district (Figs 5 & 6). In the district, the highest population of Passer domesticus was recorded along the Madurai bypass (Panjapur) and can be attributed to large scale cultivation of paddy and rice mills in the area. Large scale habitat alteration due to changing land use patterns as a result of urbanisation and waning paddy cultivation the world over is a cause of concern for declining House Sparrow populations.

## CONCLUSION

In Tiruchirappalli, bird species diversity increases from more to less urbanised centres (Clergeau et al. 1998; McKinney 2002). Though urban landscapes are less species diverse, they too play a crucial role in conserving biodiversity as they are 'Species Abundant Zones'. City planners and urban foresters should in incorporate the concept of 'Urban Bird Reserve' along urban fringes into urban landscape planning. Protecting the green cover, conserving water bodies, preserving dead trees, constructing ecofriendly architecture, and well-designed urban landscaping will help in protecting and reversing the decline of urban bird species.

# ACKNOWLEDGEMENT

The first author thanks the Department of Science and Technology, Government of India, for providing funds and assistance to carry out the project under the Women Scientists Scheme.

## REFERENCES

ARNOLD, C.L. & C. GIBBONS (1996): Impervious surface coverage: The emergence of a key environmental indicator. *Journal of the American Planning Association* 62(2): 243–258.

BEISSINGER, S.R. & D.R. OSBORNE (1982): Effects of urbanization on avian community organization. *Condor* 84: 75–83. BIBBY, C.J., N.D. BURGESS, D.A. HILL & S. MUSTOE (2000): Bird Census Techniques. 2nd edn. Academic Press, London. Pp. 325.

- BLAIR, R.B. (1996): Land use and avian species diversity along an urban gradient. Ecol. Appl. 6: 506–519.
- BLAIR, R.B. (2001): Birds and butterflies along urban gradients in two

ecoregions of the United States: is urbanization creating a homogeneous fauna? Pp. 33-56. *In:* Lockwood, J.L. & M.L. McKinney (Eds): Blotic Homogenization: The Loss of Diversity through Invasion and Extinction. Kluwer Academic Publishers, Boston, MA.

- BLAIR, R.B. (2004): The effects of urban sprawl on birds at multiple levels of biological organization. *Ecol Soc* 9(2): http:// www.ecologyandsociety.org/vol9/iss5/art2.
- BRAY, J.R. & J.T. CURTS (1957): An ordination of the upland forest communities of Southern Wisconsin. *Ecol. Monographs* 27: 325–349.
- BROTONS, L. & S. HERRANDO (2001): Reduced bird occurrence in pine forest fragments associated with road proximity in a Mediterranean agricultural area. *Landscape and Urban Planning* 57: 77–89.
- CHACE, J.F. & J.J. WALSH (2006): Urban effects on native avifauna: a review. Landscape and Urban Planning 74: 46–69.
- CLERGEAU, P., J.P.L. SAVARD, G. MENNECHEZ & G. FALARDEAU (1998): Bird abundance and diversity along an urban–rural gradient: a comparative study between two cities on different continents. *Condor 100*: 413–425.
- CROOKS, K.R., A.V. SUAREZ & D.T. BOLGER (2004): Avian assemblages along a gradient of urbanization in a highly fragmented landscape. *Biological Conservation 115*: 451–462.
- EMLEN, J.T. (1974): An urban bird community in Tuscon, Arizona: derivation, structure, regulation. *Condor 76*: 184–197.
- FRATERRIGO, J.M. & J.A. WENS (2005): Bird communities of the Colorado Rocky Mountains along a gradient of exurban development. Landscape and Urban Planning 71: 263–275.
- FRIESEN, L.E., P.F.J. EAGLES & R.J. MACKAY (1995): Effects of residential development on forest-dwelling neotropical migrant songbirds. *Conservation Biology* 9: 1408–1414.
- GLENNON, M.J. & W.F. PORTER (2005): Effects of land use management on biotic integrity: an investigation of bird communities. *Biological Conservation* 126: 499–511.
- GRIMM, N.B., J.M. GROVE, S.T.A. PICKETT & C.L. REDMAN (2000): Integrated approaches to long-term studies of urban ecological systems. *BioScience* 50: 571–584.
- JACKSON, J.A. (2006): Ivory-billed woodpecker (Campephilus principalis): hope, and the interfaces of science, conservation, and politics. Auk 123: 1–15.
- JOKIMÄKI, J. & J. SUHONEN (1993): Effects of urbanization on the breeding bird species richness in Finland: a biogeographical comparison. Ornis Fenn 70: 71–77.
- KLUZA, D.A., C.R. GRIFFIN & R.M. DEGRAAF (2000): Housing developments in rural New England: effects on forest birds. *Animal Conservation* 3: 15–26.
- LANCASTER, R.K. & W.E. REES (1979): Bird communities and the structure of urban habitats. *Canadian Journal of Zoology* 57: 2358–2368.

- MACHLIS, G.E., J.E. FORCE & W.R. BURCH JR. (1997): The Human Ecosystem, Part 1: The human ecosystem as an organizing concept in ecosystem management. *Society and Natural Resources* 10: 347–368.
- MAGURRAN, A.E. (2004): Measuring Biological Diversity, Blackwell. Pp. 260.
- MCKENNEY, M.L. (2002): Urbanization, biodiversity, and conservation. BioScience 52: 883–890.
- MCKINNEY, M.L. (2006): Urbanization as a major cause of biotic homogenization. *Biological Conservation* 127: 247–260.
- MCKINNEY, M.L. & J.L. LOCKWOOD (1999): Biotic homogenization: a few winners replacing many losers in the next mass extinction. *Trends Ecol. Evol.* 14: 450–453.
- MILLER, J.R. & R.J. HOBBS (2002): Conservation where people live and work. *Conservation Biology* 16(2): 330–337.
- MILLS, G.S., J.B. DUNNING JR. & J.M. BATES (1989): Effects of urbanization on breeding bird community structure in southwestern desert habitats. *Condor 91*: 416–428.
- MORIN, P.J. (1999): Community Ecology. Oxford University Press, Oxford, UK. Pp. 424.
- OLDEN, J.D. (2006): Biotic homogenization: a new research agenda for conservation biogeography. J. Biogeogr. 33(12): 2027–2039.
- PACYNA, J.M. & E.G. PACYNA (2001): An assessment of global and regional emissions of trace metals to the atmosphere from anthropogenic sources *Worldwide Environmental Review* 9: 269–298.
- PALOMINO, D. & L.M. CARRASCAL (2006): Urban influence on birds at a regional scale: A case study with the avifauna of northern Madrid province. *Landscape and Urban Planning* 77: 276–290.
- PRENTICE, I.C. (2001): The carbon cycle and atmospheric carbon dioxide. Pp. 185–237. *In*: Houghton, J. & D. Yihui (Eds): Climate Change 2001: The Scientific Basis. Cambridge University Press, New York.
- SHOCHAT, E. (2004): Credit or debit? Resource input changes population dynamics of city-slicker birds. Oikos 106: 622–626.
- STRATFORD, J.A. & W.D. ROBINSON (2005): Distribution of neotropical migratory bird species across an urbanizing landscape. Urban Ecosystem 8: 59–77.
- TRATALOS, J., R.A. FULLER, K.L. EVANS, R.G. DAVIES, S.E. NEWSON, J.J.D. GREENWOOD & K.J. GASTON (2007): Bird densities are associated with household densities. *Glob. Change Biol.* 13: 1685–1695.
- TURNER, B.L., W.C. CLARK, R.W. KATES, J.F. ROTMENS, & W.B. MYER (1991): The Earth as Transformed by Human Action: Global and Regional Changes in the Biosphere over the Past 300 Years. Cambridge University Press, Cambridge, UK.
- VITOUSEK, P.M., H.A. MOONEY, J. LUBCHENKO & J.M. MELILLO (1997): Human domination of Earth's ecosystems. *Science* 277: 494–499.